



The Singapore Water Story

Achieving a Diversified, Secure Water Supply

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Republic of Singapore

- Established as an independent republic in 1965 following expulsion from Malaysia
- Heavily urbanized; 5.61 million residents in 278 square miles
 - Phoenix, AZ: 1.62 million in 517 square miles
 - Las Vegas – 0.58 million in 136 square miles
- Water supply
 - Water purchases/agreements with Malaysia
 - 1961: can abstract all water within three specific areas; supply Johor treated water; 50-year duration
 - 1962: can draw 250 mgd from Johor River; supply Johor with up to 2% treated water; 99 year agreement
 - 1990: can construct Linggiu Dam; store and draw additional water from Johor River



Program for Water Sustainability: Four Taps

- Initiated in 2001 with consolidation of water supply and sanitation under the Public Utilities Board

- Purpose: diversity water supply and reduce dependence on imported water

- Comprises four distinct water supplies

- **Current water demand is 430 mgd**

- **By 2060, demand is predicted to nearly double**

- **NEWater and desalination will meet up to 85% of 2060 demand**



- 17 reservoirs capture two-thirds of rainfall in catchment areas
- In future this will increase to 90 percent
- Local runoff may supplant imported water after 2061



- Surface water delivered from the Johor River
- Currently supplies up to 50% of water demand
- When agreement expires in 2061, use of imported water may or may not be continued

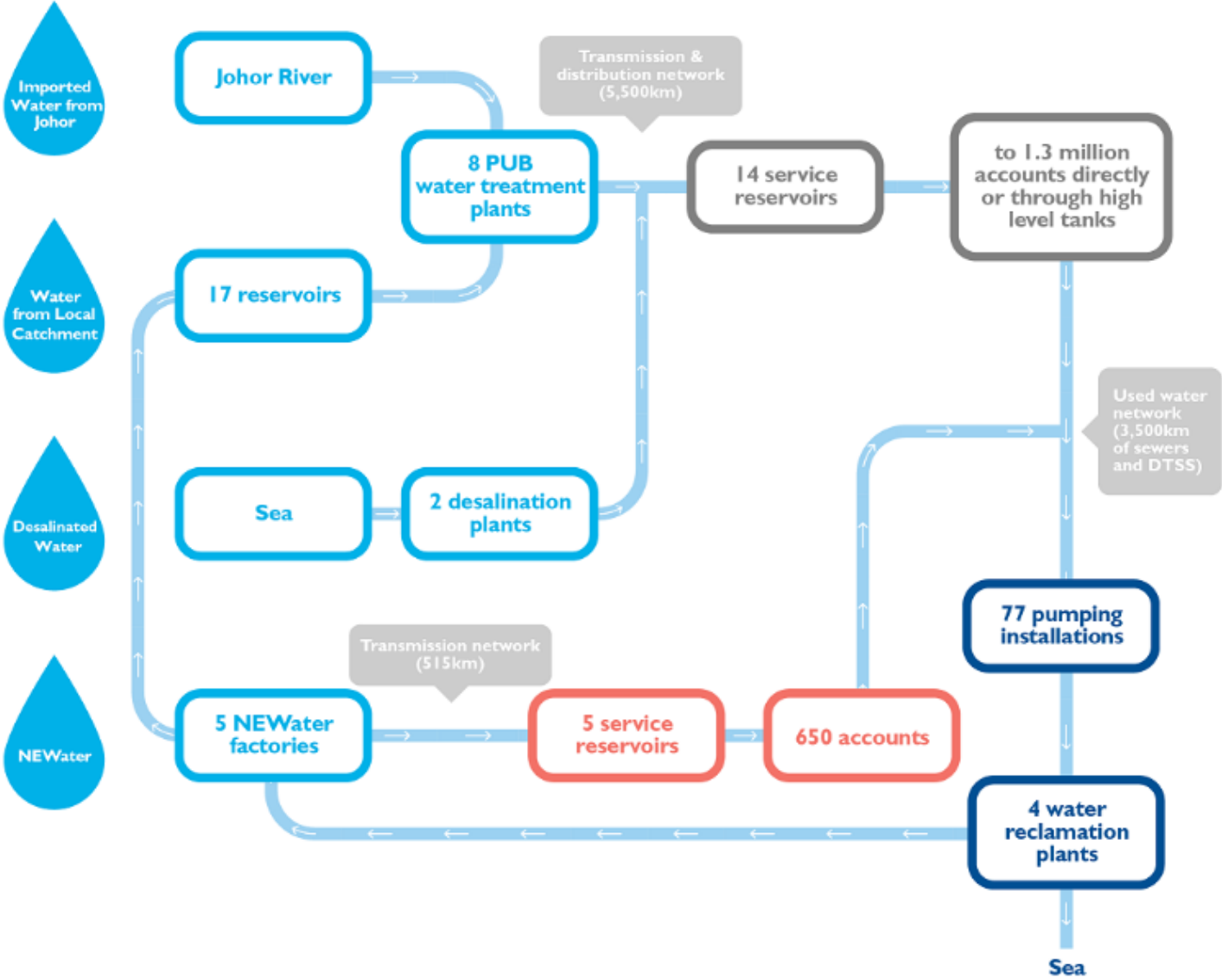


- Currently supplies 30% of water demand
- Will increase to 50% by 2060

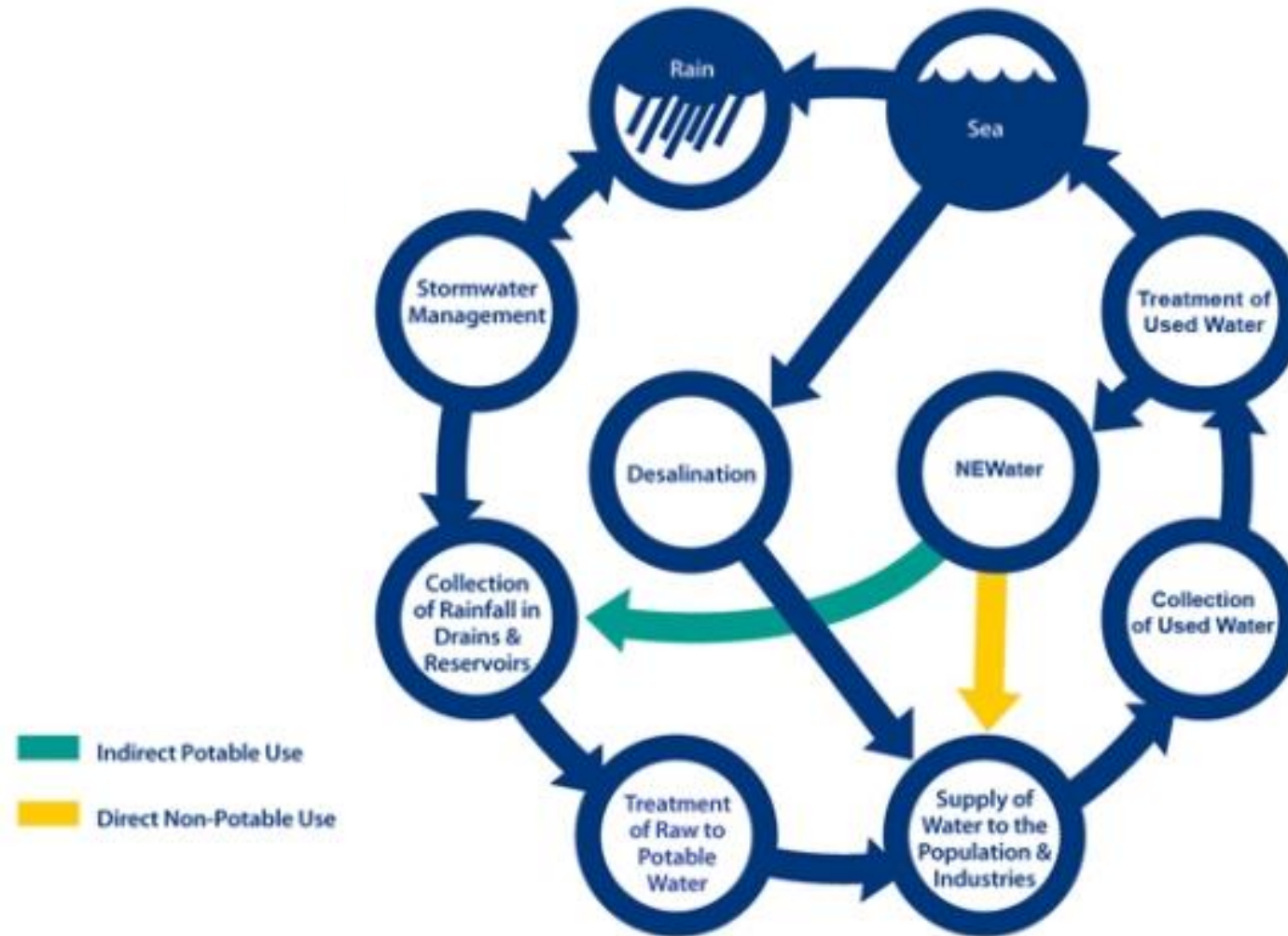


- Supplies 25% of water demand
- Will increase to 30% by 2060
- Two operating plants (SingSpring and TuasSpring)
- Third in commissioning (TDP3)
- Fourth and fifth under design or construction (MEDP and JIDP)

Four Taps Infrastructure Arrangement



The Water Loop



NEWater

- Historically, Singapore relied on Malaysia for 50% of its water supply.
- Difficulty with future water supply negotiations and steep proposed increase in water tariff was the impetus to develop additional 'local' water supplies and reduce dependence on Malaysian water.
- A Water reclamation study was initiated in 1998 as the first step in their water security program.
- The purified water produced by advanced treatment became NEWater.

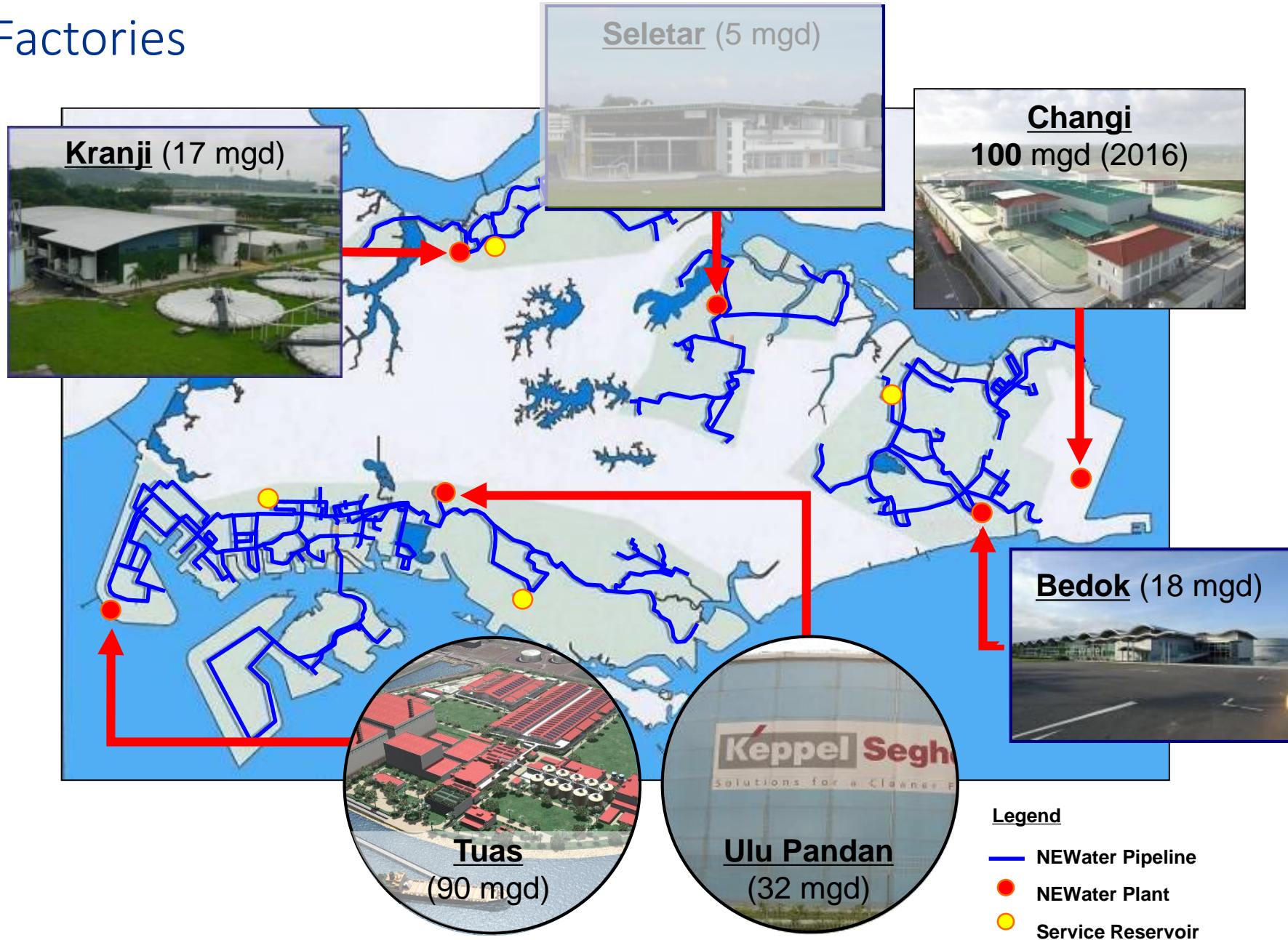
Year	Milestone
1998	Water Reclamation Study initiative conceived by PUB and the Ministry of the Environment
February 1999	CH2M HILL commissioned for the engineering design, project delivery and study management of the Singapore Water Reclamation Study
May 2000	Bedok NEWater Factory Demonstration Plant constructed and commissioned within a seven month period. Design capacity of 10,000 m ³ /day
October 2000	Commencement of the most comprehensive and sophisticated study into water reclamation: <ul style="list-style-type: none"> • Sampling and monitoring programme for some 190 water quality parameters • Toxicological assessment using both mice and fish for the first time
January 2001	PUB announces its goal to recycle 20% of secondary treated used water for industrial use
July 2001	CH2M HILL awarded the engineering design and construction supervision for full-scale Bedok and Kranji NEWater Plants, as well as interactive visitor/public education centre at Bedok. Ultimate design capacity of 168,000 m ³ /day
July 2002	Expert Panel recommends the adoption of Indirect Potable Reuse of NEWater to supplement Singapore existing water supply sources
August 2002	NEWater debuts to wide public acceptance at the National Day Parade and celebrations. Up to 60,000 bottles of NEWater given away at the on parade day.
January 2003	Bedok and Kranji NEWater Plants with an initial capacity of 72,000 m ³ /day
February 2003	The potable and non-potable use of NEWater is officially launched by the Prime Minister of Singapore at a gala event. At the same time a visitor and public education centre was opened to the public. The unique centre is fully integrated with the Bedok NEWater Plant and includes an elevated walk-through of the process area, and a multimedia interactive exhibition/education area with a 120-seat digital audio/video auditorium. The very latest in multimedia interactive learning tools are used extensively throughout the centre.

From Singapore's NEWater Demonstration Project, AWA Water, June 2003

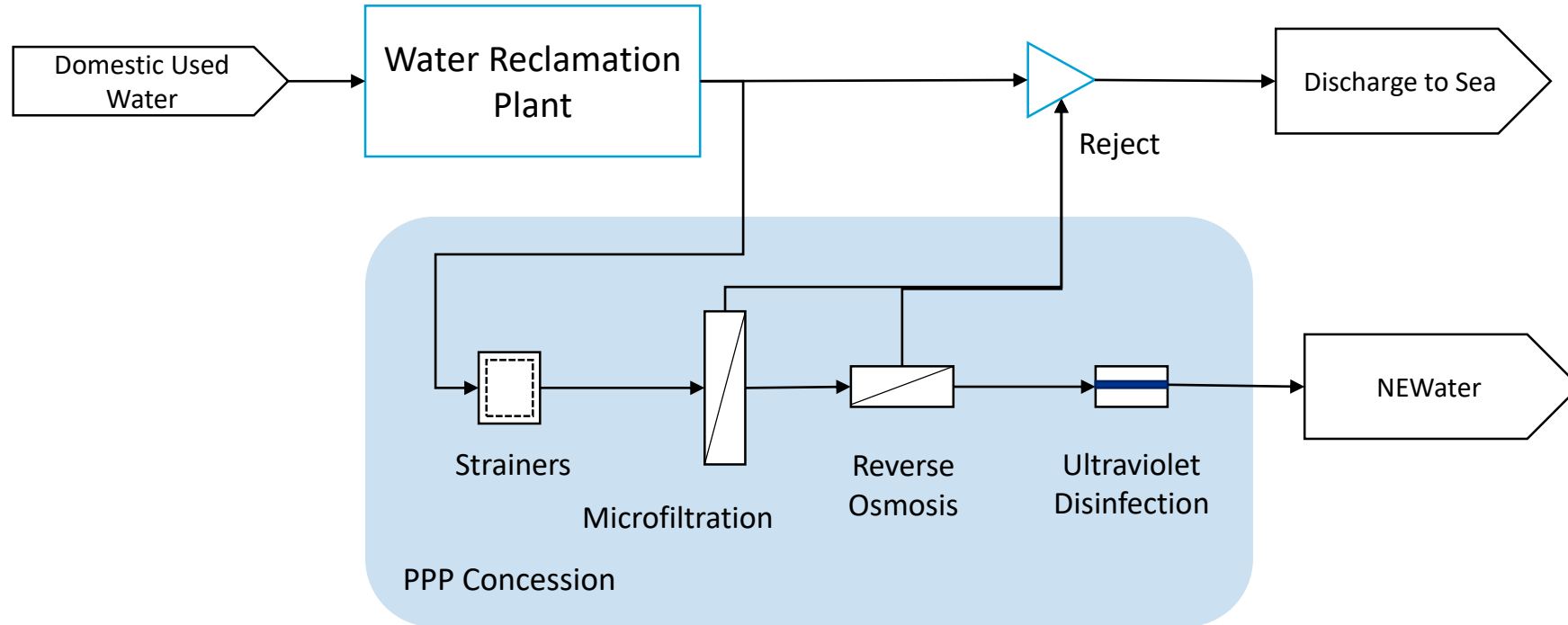
Year	Milestone
June 2004	Seletar NEWater plant with initial capacity of 24,000 m ³ /day*
March 2007	Ulu Pandan NEWater plant with initial capacity of 121,200 m ³ /day (32 mgd)
May 2010	Changi NEWater plant with an initial capacity of 189,000 m ³ /day (50 mgd)
Nov 2016	Changi NEWater plant expanded to 378,000 m ³ /day (100 mgd)
Feb 2017	Tuas NEWater plant to be constructed with <i>initial</i> capacity of 114,000 m ³ /day (30 mgd); will replace Ulu Pandan

*decommissioned in 2011

NEWater Factories



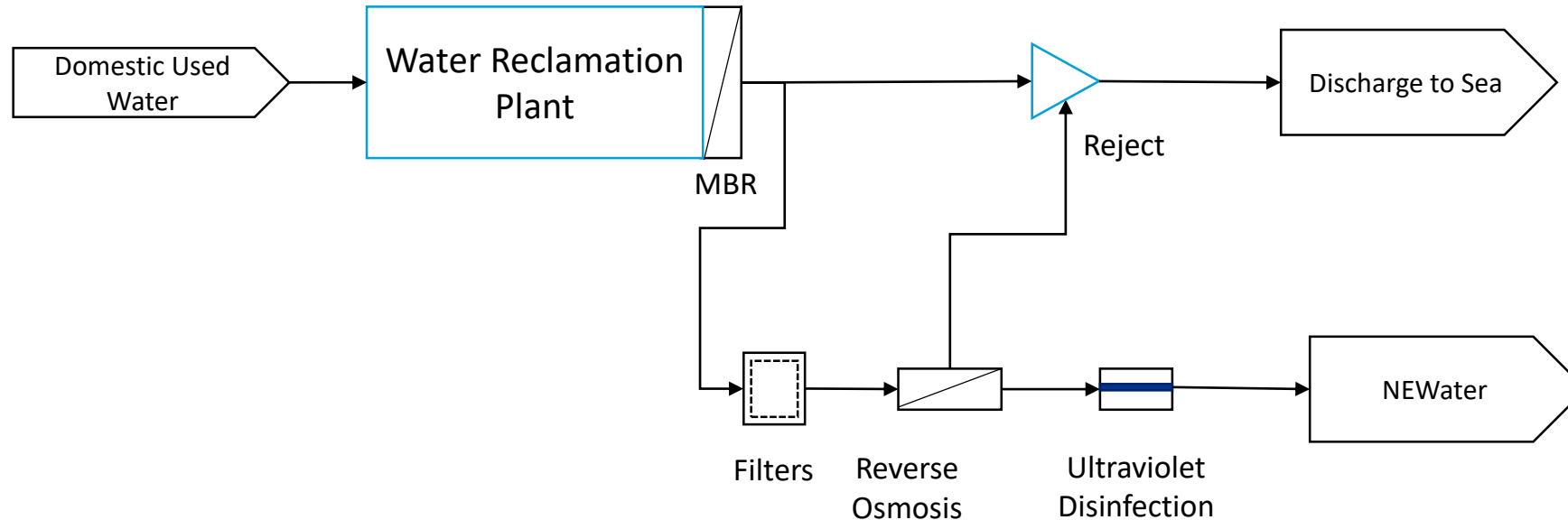
NEWater – Treatment and Uses



- Uses

- Industrial supply: semi-conductor fabs, air-con cooling, boiler feed (non-potable reuse)
- Catchment (reservoir) augmentation (indirect potable reuse)

NEWater – Updated Treatment (Changi Phase 2/NEWater Factory 3 & Tuas)



- Implemented at Changi NEWater Phase 2 and Tuas NEWater
 - Reduced footprint
 - Improved treated water quality

Tuas Water Reclamation Plant



Tuas WRP – Phase 1 Treatment and Output Capacities

- Domestic Used Water

- Nominal flow 650 MLD (172 MGD)
- Peak flow to full treatment 975 MLD (258 MGD)
- Hydraulic capacity 1,950 MLD (515 MGD)
- NEWater:
 - Initial output 114 MLD (30 MGD)
 - Stage 2 output 341 MLD (90 MGD)

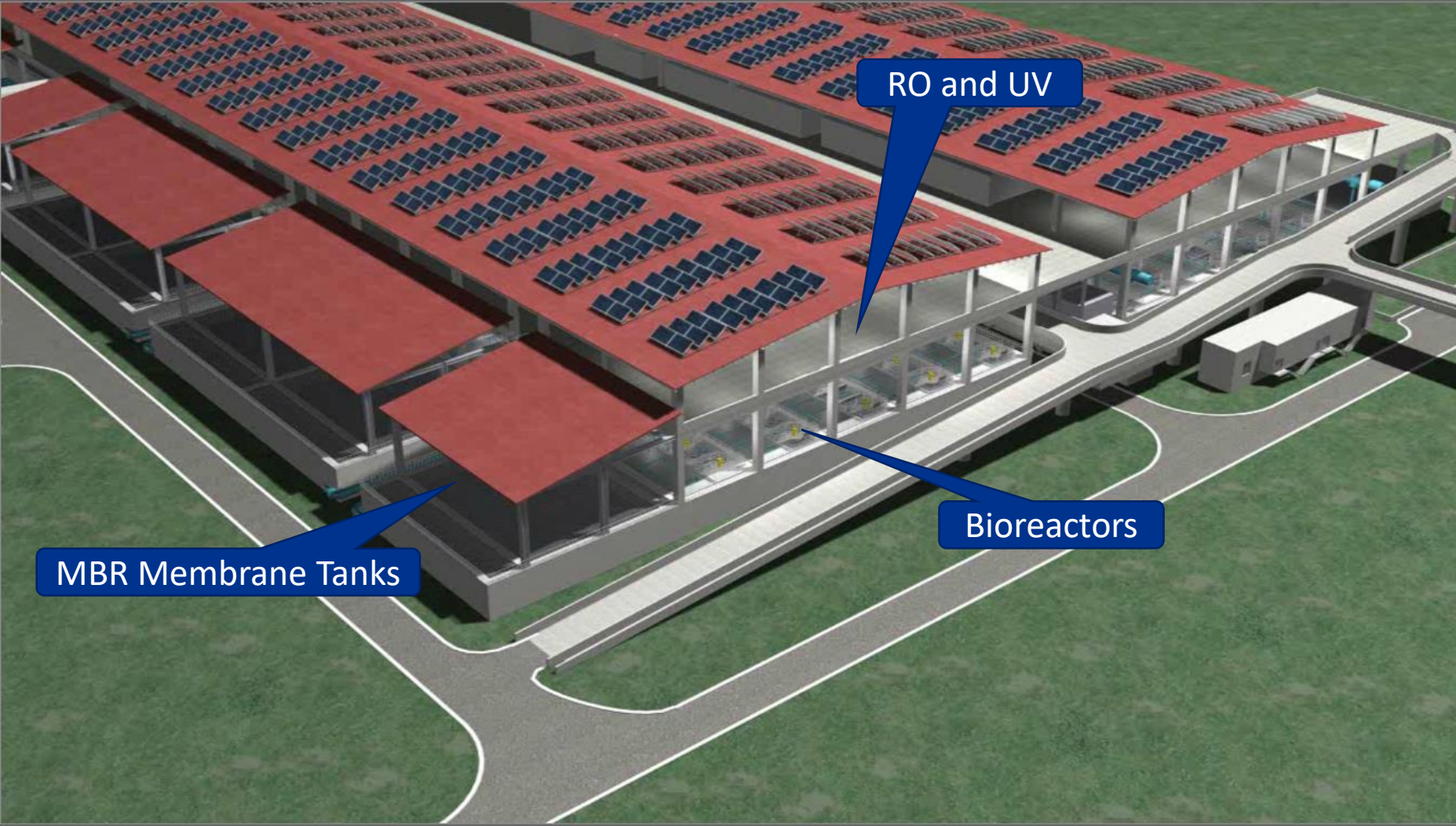
- Industrial Used Water

- Nominal flow 150 MLD (40 MGD)
- Peak flow to full treatment 225 MLD (59 MGD)
- Hydraulic capacity 450 MLD (119 MGD)
- IW:
 - Output 91 MLD (24 MGD)

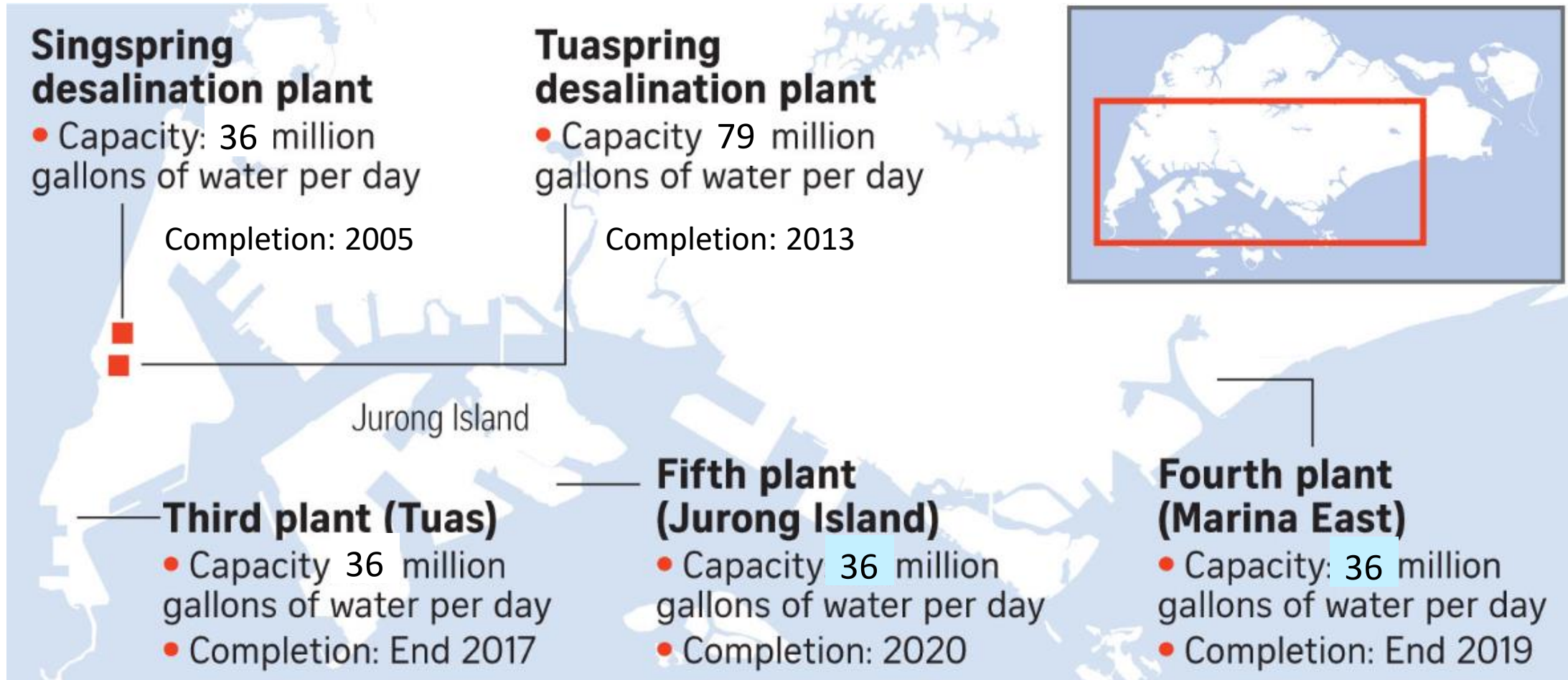
Project also includes an Integrated Waste Management Facility

- Co-digestion of WW and food wastes
- Uses biogas from the WRP; supplies energy to WRP

Concept Liquid Treatment Layout



Seawater Desalination Plants – total capacity of 223 mgd

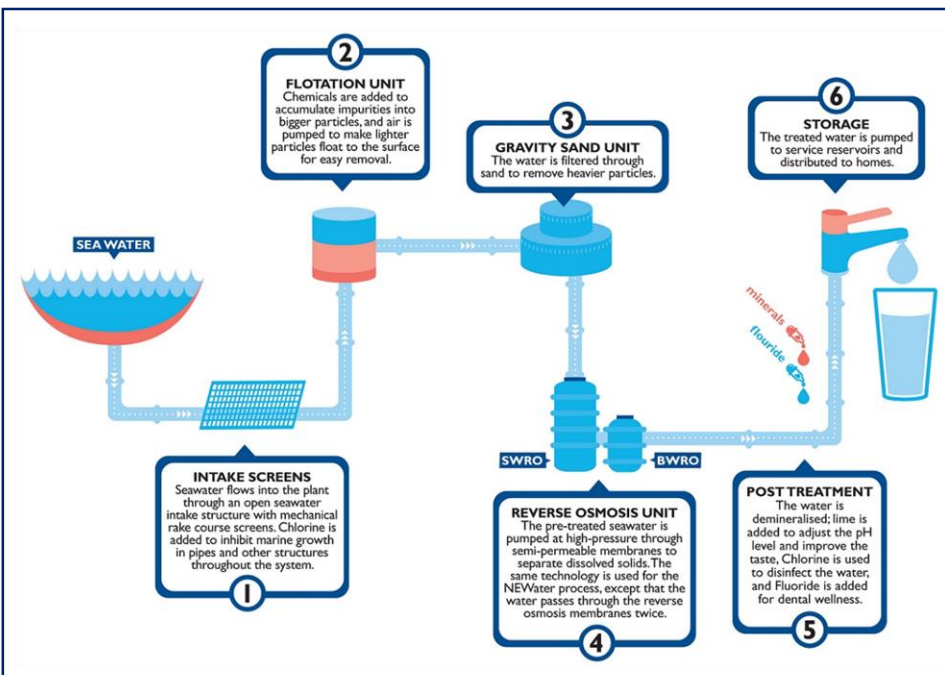
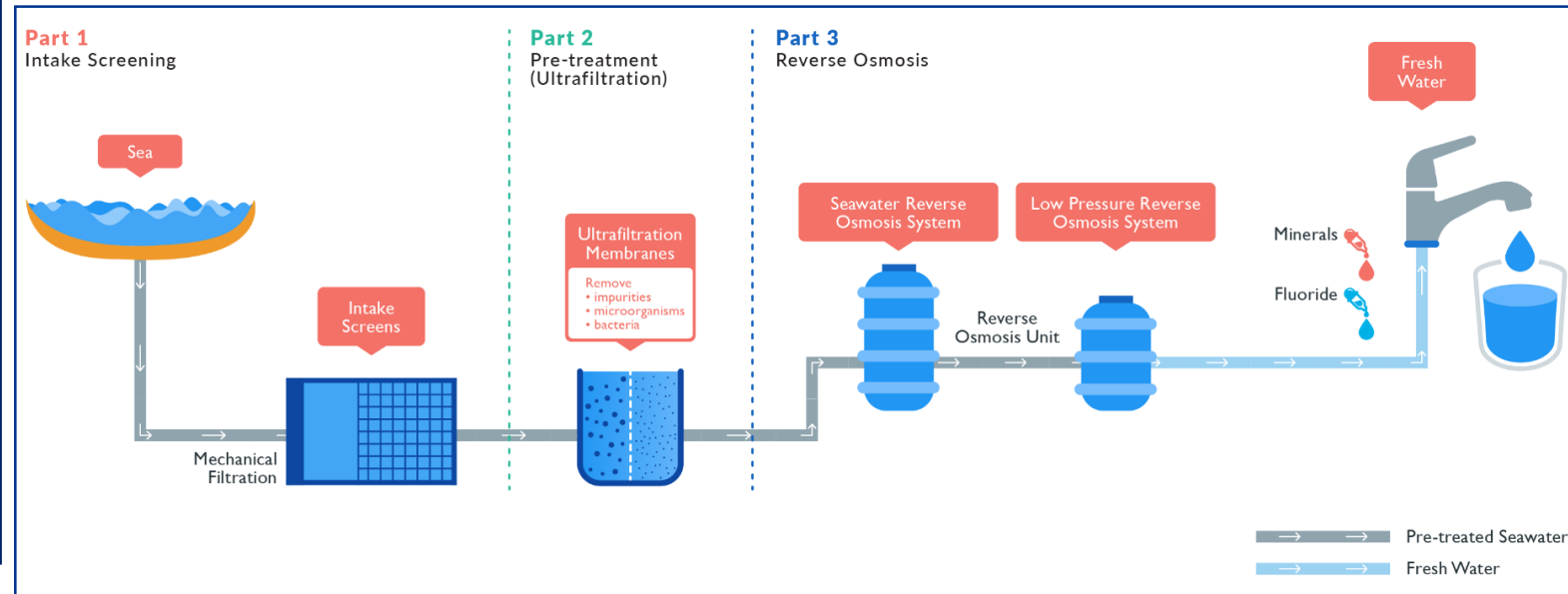


SingSpring and TuasSpring Desalination Plants

- Both BOOT contracts by Hyflux but using different pretreatments
- TuasSpring is IWPP; co-constructed with 411 MW combined cycle power plant; 1st year tariff of \$0.48/m³ (\$1.82/kgals)



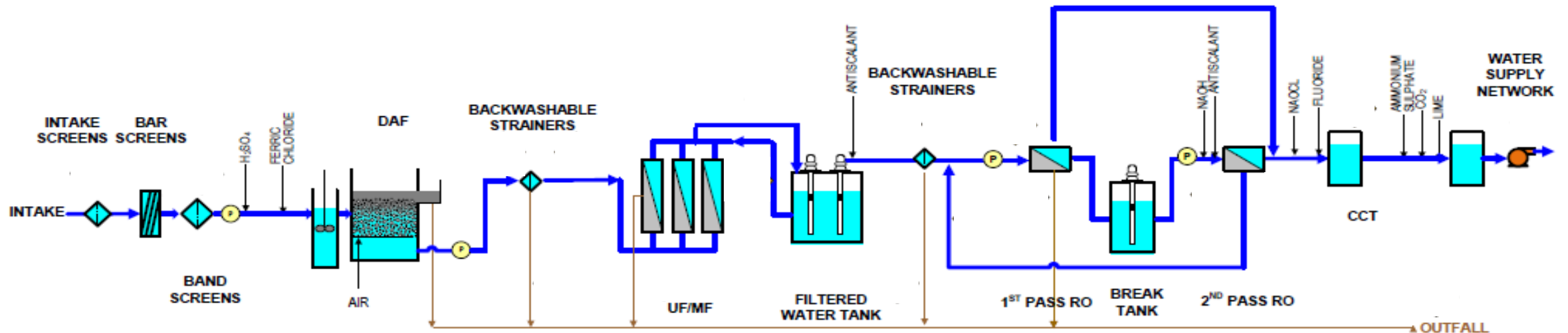
TuasSpring



SingSpring

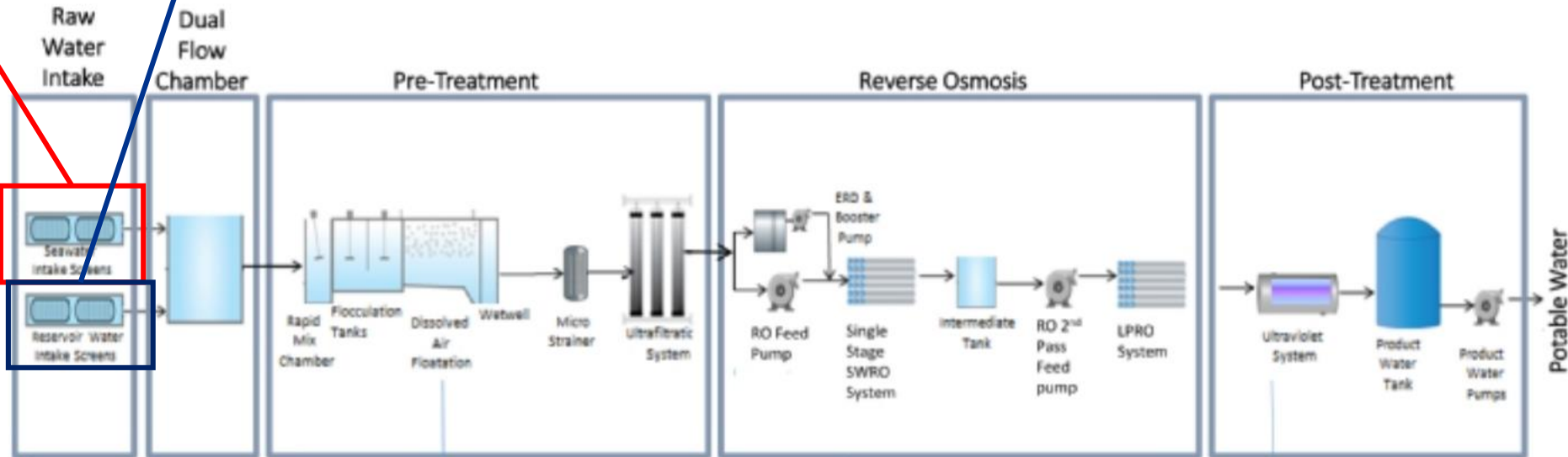
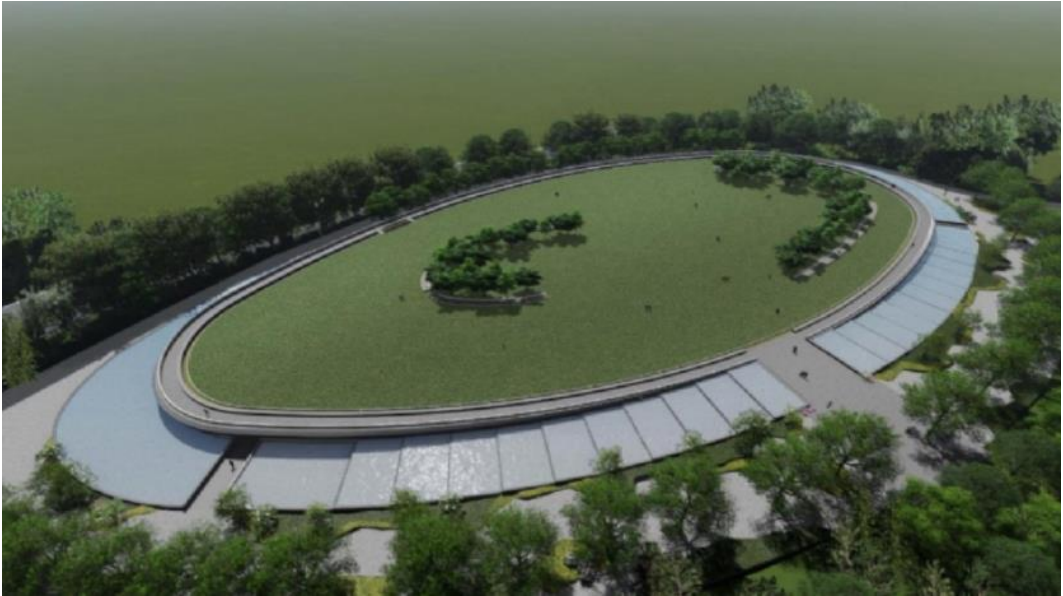
Tuas III and Jurong Island Desalination Plants

- Tuas III: owned and operated by PUB; DB by HSL Constructor Pte Ltd with Tedagua
- Jurong: 25-yr BOOT by Tuas Power-Singapore Technologies Marine at \$0.91/m³ 1st year tariff; co-located with power plant
- Engineering design and construction oversight by JACOBS/CH2M

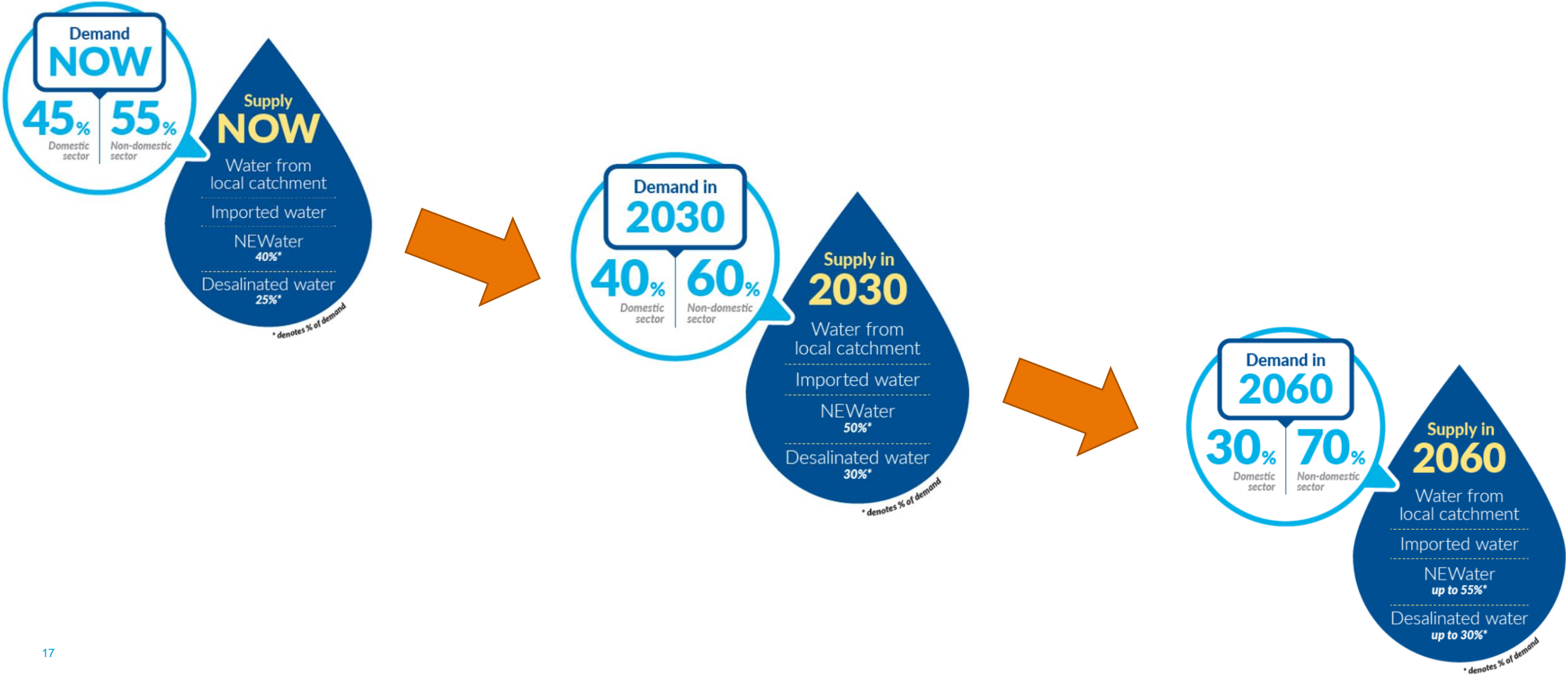


Marina East Desalination Plant

- BOOT by Keppel Engineering
- Treats both fresh water and seawater



Meeting Increasing Demand While Ensuring Water Security



Thank You!

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Process Flow Diagram

